OPTICAL FIBER INTERCONNECT CABINETS, TERMINATION MODULES AND FIBER CONNECTIVITY MANAGEMENT FOR THE SAME

RELATED APPLICATIONS

The present application claims priority from U.S. Provisional Application No. 60/456,323, filed March 20, 2003, the disclosure of which is hereby incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

The present invention relates to optical fiber management and, more particularly, to systems for connecting optical fibers.

When providing services using an optical fiber network, it is generally necessary to add and drop subscribers over time. As a result, a variety of methods are provided for interconnecting subscriber locations with a central office connecting facility operated by an optical network provider. To improve the utilization of communication circuits within such a central office facility, interconnection cabinets, such as a centralized splitter cabinet (CSC) and/or centralized splitter cross-connect (CSX), may be provided as part of the outside plant (OSP) infrastructure of the optical fiber network. Doing so may allow some of the burden of establishing and changing connections on the network to be shifted away from the central office and facilitate incremental growth of an installed network as new subscribers are added.

A centralized splitter cabinet (CSC) is typically a passive optical enclosure that provides random termination of optical splitters suitable for use in OSP environment. A CSC may be pedestal or pole mounted in the field. A CSC may provide a flexibility point for termination of distribution cable as well as enclosing a splitter array. This flexibility in interconnections of the downstream fiber network may facilitate optimization of the use of electronic equipment in the central office by, for example, avoiding the need to dedicate circuits in the central office to each subscriber location when many such locations may not be active.

A field service technician may be sent to the CSC to modify the selection of a subscriber location coupled through a splitter to a particular fiber from the central office by connecting and disconnecting various cables found in the CSC. For example, it is known to provide connectorized pigtail cables associated with each

subscriber location serviced by a CSC in the CSC. A technician can then select the cable for a designated subscriber location, for example, based on a label attached to the pigtail, and insert the selected cable in a connection point of a splitter.

Some currently available splitter interconnect cabinets utilize industry standard connectorized bulkhead modules to house splitters. These designs generally do not permit access to the rear of the connector without breaking a warranty seal and are designed for the central office environment. The seal may be critical for the manufacturer to ensure that no damage to the splitter occurs post-manufacturing (in the field). This requirement may be in direct opposition to the cleaning requirement, for which access to the front and back of a connection point may be desired.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide interconnect cabinets for optical fibers that include an enclosure and a splitter and termination panel mounted in the enclosure. The splitter has a plurality of optical fiber connectorized pigtails extending therefrom. Each of the connectorized pigtails is associated with an optical fiber feeder cable to be coupled to a central office. The termination panel has a plurality of optical fiber connection members, ones of which are associated with respective subscriber locations. The connectorized pigtails have a cable length sufficient to allow connection to the plurality of connection members.

In further embodiments of the present invention, the splitter further includes at least one input optical fiber and the splitter is configured to splice the at least one input optical fiber to the plurality of connectorized pigtails. An optical fiber cable from the central office may be coupled to the at least one input optical fiber and optical fiber cables from the subscriber locations may be coupled to the plurality of connection members. The splitter may be an optical fiber splitter tray and the enclosure may be configured to receive a plurality of optical fiber splitter trays and/or a plurality of termination panels. The plurality of connectorized pigtails may have substantially the same length. The enclosure may be a double-walled housing configured to provide passive cooling.

In other embodiments of the present invention, the termination panel is pivotally mounted in the enclosure to allow access to a front and a back side of the connection members from a front side of the enclosure. The termination panel may be a front panel of a termination module and the termination module may further

include a splice chamber configured to mount a plurality of splice modules adjacent a back side of the termination panel. The splice chamber may be pivotally mounted in the enclosure to provide access to the splice chamber from the front side of the enclosure. The termination module may be removably mounted in the enclosure to allow removal of the termination module through the front side of the enclosure. The termination panel and the splice chamber may be pivotally mounted in the enclosure for independent pivotal movement.

In further embodiments of the present invention, the termination module further includes a movable cable securing member configured to receive and secure an optical fiber cable, the cable securing member having a first position aligned with a closed position of the splice chamber and a second position aligned with an open position of the splice chamber. The cable securing member may include an attachment member configured to receive and retain a strength member of the optical fiber cable. The cable securing member may be detachable from the termination module to allow movement between the first position and the second position.

In other embodiments of the present invention, the cable securing member is pivotally attached to the termination module to allow movement between the first position and the second position. The cable securing member may pivot about a neutral axis having an arc length for a cable secured therein that is substantially the same in the first and the second positions to limit loads on the cable secured therein during movement of the cable securing member between the first and second positions.

In further embodiments of the present invention, the cabinet further includes a spooling system mounted in the enclosure and configured to receive and store excess cable length of the plurality of connectorized pigtails. The spooling system may include a plurality of spools displaced from each other in the enclosure by a distance corresponding to a distance between a first and last row of connection members on the termination panel. A distance between a first and a last of the spools may be about half the distance between first and last rows of connection members on the termination panel. The spooling system may also include an initial loop spool configured to receive all the connectorized pigtails and provide the connectorized pigtails a common entry point to the spooling system. The spools may be half-moon spools.

In other embodiments of the present invention, optical fiber termination modules include a mounting member adapted to be mounted to an interconnect cabinet for optical fibers. A bulkhead termination panel is pivotally mounted to the mounting member to allow access to a back side of the termination panel covered by the mounting member. A plurality of optical fiber connection members are mounted in the termination panel. The connection members may include a front socket configured to receive a mating optical fiber plug connector and a back socket configured to receive a mating optical fiber plug connector to provide an optical coupling between the mating optical fiber plug connectors received therein.

In further embodiments of the present invention, the termination module includes a splice chamber mounted to the mounting member proximate the back side of the termination panel. The splice chamber is configured to receive at least one splice module. The splice chamber may be pivotally mounted to the mounting member for pivotal movement separately from the termination panel. A front side of the splice chamber may face the termination panel and the at least one splice module may be received on an opposite, back side of the splice chamber. The splice module may be accessible in an open position of the splice chamber. The splice module may be a splice tray.

In other embodiments of the present invention, the termination module includes the splice module(s) and a plurality of connectorized pigtails extending from the splice module(s) to the connector members on a back side of the termination panel. The splice chamber may also include an optical fiber slack receiving region positioned between the splice module(s) and the termination panel. A mounting means may be provided for removably mounting the termination module in an optical fiber interconnect cabinet.

In yet other embodiments of the present invention, configuring an interconnect cabinet for optical fibers for outside plant management of subscriber optical fiber connectivity includes providing a termination panel in the cabinet having a plurality of optical fiber connection points and a splitter in the cabinet having a plurality of optical fiber connectorized pigtails extending therefrom, the connectorized pigtails have a cable length sufficient to allow connection to the plurality of connection points. The connectorized pigtails are optically spliced to an optical fiber feeder cable coupled to a central office. The plurality of optical fiber connection points are optically spliced to respective subscriber locations.

In further embodiments of the present invention, ones of the connectorized pigtails are selectively coupled to ones of the connection points to provide service to designated ones of the subscriber locations. One of the connectorized pigtails may be selectively decoupled from one of the connection points to terminate service for a designated one of the subscriber locations. The cabinet may further include a plurality of fiber management spools and the connectorized pigtails may be routed around selected ones of the fiber management spools based on a location of a connection point to which they are to be coupled. The pigtails may be optically spliced to an optical fiber feeder cable coupled to a central office in a splice closure outside of the interconnect cabinet.

In other embodiments of the present invention, interconnect cabinets for optical fibers include an enclosure and a termination panel mounted in the enclosure and having a plurality of optical fiber connection members, ones of which are associated with respective subscriber locations or are associated with an optical fiber feeder cable to be coupled to a central office. One or more jumper cables are provided for cross-connecting ones of the connection members. A spooling system mounted in the enclosure is configured to receive and store excess cable length of the jumper cable(s). The jumper cable(s) have a cable length sufficient to allow cross-connecting of the plurality of connection members. The spooling system may include a plurality of spools displaced from each other in the enclosure by a distance corresponding to a distance between a first and last row of connection members on the termination panel. The spooling system may further include a mid-point spool.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram illustrating an interconnect cabinet for optical fibers according to some embodiments of the present invention;

Figure 2 is a front perspective view of an interconnect cabinet for optical fibers according to some embodiments of the present invention;

Figure 3 is a front perspective view of an interconnect cabinet for optical fibers according to some embodiments of the present invention;

Figure 4 is a perspective view of a termination module according to some embodiments of the present invention with the termination panel in an open position;

Figure 5 is a front perspective view of an interconnect cabinet for optical fibers according to some embodiments of the present invention showing installation of a termination module in the cabinet;

Figure 6a is a perspective view of a termination module according to some embodiments of the present invention in a closed position;

Figure 6b is a perspective view of the termination module of **Figure 6a** in an open position showing the splice chamber and trays;

Figure 6c is a perspective view of the termination module of **Figure 6a** in another open position showing the back side of the termination panel;

Figure 7a is a side view of a termination module according to some embodiments of the present invention;

Figure 7b is a front perspective view of the termination module of **Figure 7a**;

Figure 8 is a side view of the cable securing member of the termination module of **Figure 7a** according to some embodiments of the present invention;

Figure 9 is a perspective view of an optical fiber splitter/splice tray having a plurality of connectorized pigtails according to some embodiments of the present invention;

Figure 10 is a perspective view of an optical fiber splitter/splice box having a plurality of connectorized pigtails according to some embodiments of the present invention; and

Figure 11 is a flowchart illustrating methods for outside plant management of subscriber optical fiber connectivity according to some embodiments of the present invention.

DETAILED DESCRIPTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which illustrative embodiments of the invention are shown. In the drawings, the relative sizes of regions or features may be exaggerated for clarity. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Some embodiments of the present invention utilize a multi-layer, fold down tray approach to support various functions, such as slack storage, pigtail to outside

plant (OSP) cable splicing and angle down front patching. A termination module according to such embodiments may be designed in a modular fashion so that it can be used separately in a small pedestal or ganged together with other termination modules in a pad (i.e. ground) or pole mounted cabinet. The termination modules may also be pre-terminated to subscriber location optical fibers before mounting in an interconnect cabinet. The termination modules in some embodiments may also be removed from the cabinet and carried to a remote location, such as a splice truck, to facilitate initial installation.

The termination modules in some embodiments include splice trays therein that may be oriented such that they can be worked on remotely or in the cabinet when a repair situation arises. In some embodiments, the entire patching field pivots downward and/or sideways, allowing access to both sides of the connector for cleaning while potentially reducing or avoiding the normal disruption of disconnecting existing subscribers to gain access. Cleaning both sides of an optical connector may be beneficial, particularly when using connectors in the OSP. A detachable cable security member is incorporated into some embodiments of the termination module of the present invention, which may allow fixation of the cable as well as the central strength member in both an open and closed position of the termination module without placing undue strain on the cable from a change in orientation of the termination module during installation or the like.

The cable security member of some embodiments of the present invention need only be separated from the termination module during closing (when the termination panel is moved from an open to a closed position). The relative position of the cable security member to the splice trays may remain substantially unchanged during the closing (or opening).

A splitter module array (one or more splitters) can be built up incrementally in a cabinet by adding one pre-connectorized splitter module at a time in some embodiments of the present invention. The splitter module may, for example, be splitter/splice trays coupled to a hanger bracket for purposes of mounting. However, alternative embodiments may use a splitter box that is loaded into a rack or some other bracket. Labels on the forward facing edge of the splitter module may be included to indicate subscribers allocated to that splitter. Labels on the front of the splitter module could also be included to indicate test data and/or relevant manufacturing information.

In some embodiments of the present invention, random over-length storage of connectorized pigtails exiting the splitters may incorporate the use of half-moon spools, which may provide bend control as well as incremental slack compensation. The spools may be, for example, evenly spaced such that each spool is allocated to specific fields of the patch panel, which may simplify tracing of pigtails.

In various embodiments of the present invention, only front access may be needed to work on cabinet. General fiber management and organization may be a problem with existing cabinet designs. Some embodiments of the present invention may overcome these shortcomings by regrouping the various functions (splicing, patching, splitting) in a way that may be counter-intuitive to standard practices. This regrouping of functions may significantly increase productivity, craft friendliness and/or maintainability of fiber management in interconnect cabinets according to some embodiments of the present invention.

For some embodiments of the present invention, as will be described further herein with reference to the figures, shifting the bulkhead connection point from the splitter to a patch panel may permit access to both sides of the connection point for cleaning. Also, for some embodiments of the present invention, a reduced number of loose /unterminated pigtails may need to be managed during routine maintenance and reconfiguration. Various embodiments of the present invention may provide for 216 or more pigtails hanging in bunches and that number may be incrementally reduced as subscribers are added to the network. Some embodiments of the present invention may reduce this congestion to a maximum of 15 fibers for 1x16 splitters or 31 for 1x 32 splitters. This smaller number may be reduced as subscribers are added until none are left and a new splitter is added. The unused pigtails may be stored on the side of the cabinet segregated from the active fibers. The patch panel design may allow subscribers to be identified quickly as contrasted with other known approaches that require the craft to fumble through bundles of pigtails in search of one specific customer that has subscribed to the network and needs connecting.

Embodiments of the present invention will now be described with reference to the various embodiments illustrated in **Figures 1-11**. **Figure 1** is a schematic diagram illustrating an interconnect cabinet **100** for optical fibers according to some embodiments of the present invention. As shown in **Figure 1**, the interconnect cabinet **100** is used for connecting subscriber cable(s) **105** with the central office outside plant (OSP) cable(s) **110** so as to manage connectivity of subscriber locations

to the central office. The interconnect cabinet **100** includes splice modules **115a**, **115b**, a termination module **130** having a front face that provides a patch panel, a splitter module **140** and connectorized pigtails **150a**, **150b**.

As will be understood by those of skill in the art, the splice modules **115a**, **115b** may be used to connect optical fibers from the cables **105**, **110** to a backside of the optical fiber connection points (members) **120a**, **120b**. While two splice modules **115a**, **115b** are illustrated in **Figure 1**, more splice modules may be used depending upon the number of fibers to be routed through the interconnection cabinet **100**. Furthermore, although a separate splice module **115b** is shown for use with the central office cable **110**, in various embodiments of the present invention, a common splice module may be used for both the cable fibers of the subscriber **105** and the central office **110**. Although splice modules for making such interconnections provide benefits in routing and control of radius of curvature and the like of optical fibers, it will understood that the present invention, in some embodiments, encompasses other methods of interconnect between the subscriber and central office cables **105**, **110** and the fiber connection points **120a** and **120b**.

As shown in **Figure 1**, the splitter module **140** has a connectorized pigtail **150a** extending to a fiber connection point **120b** to optically couple to a fiber from the central office. The fiber from the central office is connected by the splitter module **140** to the plurality of connectorized pigtails **150b**. Thus, each of the connectorized pigtails **150b** are associated with an optical fiber feeder cable **110** coupled to a central office, typically through an individual fiber. The splitter module **140** may be a 4 to 1, 16 to 1, 32 to 1 or the like splitter module based on the desired number of subscribers to be carried and supported by a single fiber feed to the central office.

As illustrated in the embodiments of **Figure 1**, ones of the fibers from the subscriber cable **105** associated with different subscriber locations are each coupled to respective ones of the fiber connection points **120b** in the patch panel front face of the termination module **130**. The connectorized pigtails **150b** have a cable length sufficient to allow connection of each of the pigtails **150b** to the plurality of connection points **120b**. As a result, service to an individual subscriber location may be readily provided or ended by coupling or decoupling one of the connectorized pigtails **150b** from the one of the fiber connection points **120b** associated with that subscriber. Therefore, providing a readily determined location on the front patch panel of the termination module **130** associated with each specific subscriber may

simplify the task of making a connection for a field technician who might otherwise have difficulty locating a pigtail **150b** associated with a specific subscriber.

For the embodiments illustrated in **Figure 1**, the fiber feed to the central office from the central office cable(s) **110**, like the fiber feed of the subscriber cable(s) **105**, is coupled through a splice module **115b** to an interconnection point **120b** on the patch panel front face of the termination module **130.** While shown as a separate connection points **120a, 120b** in **Figure 1**, it will understood that any of the connection points **120b** could likewise be used to provide an interconnection to the central office cable(s) **110**. It will be further understood that, in some embodiments of the present invention, the input optical fiber to the splitter module **140** is spliced to a fiber in the central office cable(s) **110** directly without use of the termination module **130** and the connectorized pigtail **150a**. For example, the input optical fiber to the splitter module **140** could be coupled to a fiber from the central office cable(s) in the splice module **115b**.

The present invention will now be further described with reference to the embodiments of an interconnect cabinet **200** for optical fibers illustrated in **Figure 2**. As shown in **Figure 2**, the interconnect cabinet **200** includes an enclosure **202** having an upper chamber **210** and a lower chamber **205**. The enclosure **202** may be a double-walled housing configured to provide passive cooling for the cabinet **200**. The subscriber and central office cables **105, 100** are received in the lower chamber **205**, which is protected by a front cover panel **207**. The cables **105, 100** feed through a bottom panel **252** positioned between the upper chamber **210** and the lower chamber **205** through grommets **254**. Thus, for example, in the embodiments of **Figure 2**, the upper chamber **210** may be provided a cleaner or more environmentally controlled environment than the lower chamber **205**. However, it will be understood that various embodiments of the present invention may provide for direct routing of the cables **105** and **110** into the upper chamber **210** of a single chamber enclosure not having a separate lower chamber.

As shown in the embodiments of **Figure 2**, a termination module **230**, a plurality of splitter modules **240** having connectorized pigtails **250** and a plurality of spools **270, 272** are positioned in the upper chamber **210** of the housing **202**. The termination module **230** is removably mounted to a back wall **212** of the upper chamber **210**. The splitter modules **240** are removably mounted to the back wall **212** by brackets **242**.

The termination module **230** includes a termination patch panel **232** on its front face that includes a plurality of optical fiber connection points (members) **220**. The connection members **220** include sockets **221** configured to receive the connectorized plugs of the pigtails **250**. As also shown in the embodiments of **Figure 2**, the termination patch panel **232** may be modified based on the number of optical fibers to be connected by adding additional rows of connection members **220** in the regions **222**. Three brackets **234** are shown on the termination module **230** that may be used to rest on a table or other flat surface when the termination panel **232** is rotated open to allow access to a backside of the connection member **220**.

The arrangement illustrated in **Figure 2** may allow for front panel access to the various connectivity components for arranging connections to subscriber locations. As shown in **Figure 2**, front side access to the cabinet **200** is provided by opening of the rotatable door panels **260** defining the front panel of the interconnect cabinet **200**. However, a single panel door, removable panel or the like could also be provided to allow front side access to the chamber **210**.

The spooling system **270, 272** may be used to support routing of the pigtails **250** in a manner that may advantageously control bending of the pigtails **250** to reduce the risk of damage to the optical fiber and provide further organization to the routing of the pigtails **250**, particularly where a fully loaded interconnect cabinet **200** may include a large number of such pigtails **250**. The spooling system **270, 272** is mounted in the enclosure **202** and configured to receive and store excess cable length of the connectorized pigtails **250**. The spools **270,** in some embodiments of the present invention, are displaced from each other in the enclosure by a distance corresponding to a distance between a first and last row of the connection points **220** on the termination patch panel **232**. In other words, as viewed in **Figure 2**, a distance from a bottom to a top one of the spools **270** may correspond to a distance from a bottom to a top row of the interconnection members **220**.

As also shown in **Figure 2**, the spooling system **270, 272** may include an initial loop spool **272** configured to receive all the connectorized pigtails **250** and provide the connectorized pigtails a common entry point to the spools **270**. Thus, all of the pigtails **250** may first be routed underneath the initial loop spool **272** and then over a selected one of the spools **270** based on the relative distance from the bottom panel **252** of an associated row of the connection members **220** to which the pigtail **250** is to be routed. The half-moon spools illustrated in **Figure 2** may have a radius

selected to provide the desired protection against damage due to bending of fibers in the pigtails **250**. The connectorized pigtails **250** in some embodiments of the present invention are provided with substantially the same length. Use of selected ones of the spools **270** in routing may provide for occupying more or less unused length of such pigtails **250** based on which connection member row the pigtail **250** is routed to on the termination panel **232**.

A plurality of splitter modules **240** and a single termination module **230** are illustrated in **Figure 2**. However, as seen by the space between the splitters **240** and the termination module **230**, a plurality of termination modules **230** may be selectively mounted in the enclosure **202** in some embodiments of the present invention.

Figure 3 is a front perspective view further illustrating some embodiments of the present invention. In particular, **Figure 3** illustrates the interconnect cabinet of **Figure 2** with only one installed splitter module **240** and a second splitter module **240** in the process of being installed. For the embodiments in **Figure 3**, the splitter modules **240** are splitter trays having hanger brackets **344** attached thereto. The hanger brackets **344** engage the brackets **242** to mount the splitter trays **240** in the interconnect cabinet **200**. Also illustrated in the embodiments of **Figure 3** is a hook **305** in a sidewall of the enclosure **202** that may be used to hang unused pigtails **250**. The hook **305** in some embodiments of the present invention may be a spool, such as a half-moon spool.

Some embodiments of the present invention provide for routing of jumper cables to provide a cross-connect between two of the interconnection members **220**, as contrasted with routing of pigtails **250** from the splitter modules **240**. In such embodiments, the hook or mid-point spool **305** may be used and positioned at a location above the spools **270** to facilitate routing of the jumper cables. For example, the hook or mid-point spool **305** could be positioned to provide a turn-around point at the mid-point of the jumper cable length.

Figure 4 is a perspective view of a termination module **430** according to some embodiments of the present invention with a termination panel **430a** (the front face of which defines a patch panel) in an open position. The termination panel **430a** may be moved to the illustrated open position by rotation about a pivot point **476** so as to allow access from the front of the interconnect cabinet **400** to a backside **420'** of the interconnection members **220** mounted in the patch panel **432** of the termination panel

430a. As with the front side interconnection members **220** having sockets **221** (see **Figure 2**), the backside interconnection points **420'** in the embodiments of **Figure 4** include sockets **421** configured to receive connectorized pigtails **480** extending from a splice module **115a, 115b** coupled to the subscriber and/or central office cables **105, 110**.

The pigtail **480** may extend from a splice chamber **430b** by, for example, routing through a protective conduit **472b** or a hardened cable **472b**. The cables **472a, 472b** may extend from splice modules **115a, 115b** mounted in the splice chamber **430b** through an optical fiber slack receiving region **474** of the splice chamber **430b**. The splice chamber **430b** may also be pivotally mounted in a manner such that access to the splice region from the front side of the interconnect cabinet **400** is provided via rotation of the splice chamber **430b** about a pivot point **478**.

A mounting member **430c** of the termination module **430b** may support the pivot points **476, 478** and provide for mounting of the termination module **430** in the interconnect cabinet **400**.

Also visible in **Figure 4** are the backside **470** of the patch panel **432**, brackets **434** and half-moon spools **470, 472**. The arrangements of the spools **470, 472** differs from that described with reference to the spools **270, 272** of **Figure 2** in that the lower initial loop spool **472** is aligned with the plurality of spools **470** rather than being offset toward the left side of the cabinet **200** as illustrated in **Figure 2**.

Figure 5 is a front perspective view of an interconnect cabinet **500** for optical fibers according to some embodiments of the present invention showing installation of a termination module **530** in the cabinet **500**. As seen in **Figure 5**, the termination module **530** may be manually removed with the cables **105, 110** connected thereto by passing excess length of the cables **105, 110** through the grommets **254**. Such excess cable length may be stored in the lower chamber of the cabinet **500** or may be drawn from outside the cabinet **500** at a time when a technician removes the termination module **530** from the cabinet **500**.

As seen in the embodiments of **Figure 5**, the termination module **530** includes a termination panel **530a**, a splice chamber **530b** and a mounting member **530c**. The respective elements **530a, 530b, 530c** may operate substantially the same as described in **Figure 4** with reference to like numbered elements (**430a, 430b, 430c**).

Further embodiments of the termination module according the present invention will now be described with reference to **Figures 6a, 6b**, and **6c**. **Figure 6a**

is a perspective view of the termination module **630** in a closed position. **Figure 6b** is a perspective view of the termination module **630** of **Figure 6a** in a first open position showing a splice chamber **630b** and trays **615**. **Figure 6c** is a perspective view of the termination module **630** of **Figure 6a** in a second open position showing the backside of a termination panel **630a**. The termination module **630** includes the termination panel **630a**, a splice chamber **630b**, and a mounting member **630c**. The termination panel **630a** and splice chamber **630b** are each rotatably mounted to the mounting member **630c**. A plurality of brackets **634** are positioned on the termination panel **630a** so as to provide means for resting the termination module **630** on a table or other flat surface in the open position orientation of **Figure 6b** or **Figure 6c** to facilitate work on splices and the like by a technician setting up the termination module **630** while reducing the risk of damage to the interconnection members **620**.

A movable cable securing member **682** is configured to receive, secure and/or provide strain relief for an optical fiber cable **105, 110**. The moveable cable securing member **682** is illustrated in a first position aligned with a closed position of the termination panel **630a** and a splice chamber **630b** in **Figure 6a** and a second position aligned with an open position of the termination panel **630a** and splice chamber **630b** in **Figure 6b**. The moveable cable securing member **682** in **Figures 6a, 6b** and **6b** is mounted so as to align with the splice chamber **630** and splice modules **615** in each position to reduce the risk of damage due to bending of the optical fiber cables **105, 110**.

Figure 6a illustrates an arrangement and orientation suitable for use when installed in an interconnect cabinet allowing access to the front side of the interconnection members **620**. **Figure 6c** illustrates allowing access to the backside **620'** of the interconnect members **620**. In contrast, **Figure 6b** illustrates a position suitable for use during set up of the termination module **630** by a technician providing splices to fibers of the cables **105, 110** using the splice modules **615**.

For the embodiments of the moveable cable securing member **682** illustrated in **Figure 6b**, temporary brackets **686** may be provided to hold the cable securing member **682** in the second position aligned with the opened splice chamber **630b**. As shown in **Figure 6b**, an attachment member **688** is provided that is configured to receive and retain a strength member of an optical fiber cable **105, 110**. For the illustrated embodiment, the attachment member **688** is a bolt, which may couple to a retaining member, such as a bracket or clamp, positioned on an opposite face of the

cable securing member **682**. In addition, further support may be provided by attaching the outer jacket of the cable **105, 110** with a hose clamp, twist tie or the like to the tie off tabs **684**.

The illustrated cable securing member **682** in **Figure 6b** includes two flat plate members, each of which may be configured to receive two cables **105, 110**. It is to be understood that other attachment members may be provided using various securing or clamping devices suitable for securely grasping a strength member of a cable and that one or more such attachment members may be provided for use with each cable secured by the cable securing member **682**.

As shown by **Figure 6b** and **Figure 6c**, the termination panel **630a** and splice chamber **630b** are pivotably mounted to the mounting member **630c** for independent pivotal movement. The mounting member **630c** is configured for mounting in an interconnect cabinet **200, 300, 400, 500** using for example, the mounting holes **631** illustrated in **Figure 6b**.

Before opening the termination module **630** from the position of **Figure 6a** to the position of **Figure 6b**, the cable securing member **682** may be detached from the mounting member **630c**. The termination panel **630a** and splice chamber **630b** may then be pivoted to the open position of **Figure 6b** and the cable securing member **682** may be secured into the position shown in **Figure 6b** using the brackets **686**. When operations related to splicing and the like are completed, a technician may remove the cable securing member **688** and the brackets **686** and reattach the cable securing member **682** as shown in **Figure 6c** to maintain an orientation aligned with the splice chamber **630b** in the closed position of the splice chamber **630b** relative to the mounting member **630c**. In addition, **Figure 6a** shows the front side of the interconnection members **620** accessible on the patch panel **632** while **Figure 6c** shows access to the backside **620'** of the interconnection members.

Figure 6b shows additional details of the splice chamber **630b**. In particular, the splice modules **615** are pivotally mounted to respective angle mounting brackets **617** to provide access to different ones of the stacked plurality of splitter modules **615**. Before completing the splicing of individual fibers within the splitter modules **615**, an excess length of respective optical fibers may be provided for future use and/or modification in the optical fiber slack receiving region **674**. The optical fiber slack receiving region **674** illustrated in **Figure 6b** is positioned between the splice modules **615** and the termination panel **630a**.

Figure 7a is a side view of a termination module **730** according to further embodiments of the present invention. **Figure 7b** is a front perspective view of the termination module **730** of **Figure 7a**. As shown in **Figures 7a** and **7b** the termination module **730** includes a termination panel **730a**, a splice chamber **730b** and a mounting member **730c**. A region for a plurality of interconnection members **720** are provided in the patch panel **732** defined by the front face of the termination panel **730**. None of the interconnection points are mounted in the patch panel **732** as illustrated in **Figure 7b**. However, as shown in **Figure 7a**, the patch panel **732** includes angled strips **796** configured to receive a plurality of interconnection members. The downward angle orientation illustrated for the strips **796** may provide improved safety for the installer by reducing the risk of light being directly aimed at the installer's eyes and/or may provide reduced infiltration of dirt and the like to the interconnection members **720** due to gravity.

The arrangement for positioning of the interconnection members **720** in **Figure 7b** differs from that described previously with reference to **Figure 6a** primarily in the provision of a staggered alignment for rows of the interconnection members **720**. Such an arrangement may provide for improved accessibility of the interconnection members **720**, as the cascading of pigtails feeding to the interconnection members **720** may less heavily overlay lower position interconnection member rows in the patch panel **732**. The embodiments of **Figure 7b** and **7b** further illustrate angled mounting brackets **717** for use in pivotally mounting splice modules, such as optical splice trays, in a stacked relationship.

The embodiments of **Figures 7a** and **7b** further differ from those described with reference to **Figures 6a- 6c** in the particulars of the moveable cable securing member **782**. As illustrated in the side view illustration of **Figure 8**, the cable securing member **782** is pivotable between a first position A aligned with a closed position of the termination panel **730a** and splice chamber **730b** and a second position B aligned with an open position of the termination panel **730a** and the splice chamber **730b**. An attachment member **688** and tie-off tab **784** may be provided for securing a respective optical fiber cable as described previously with reference to the similarly numbered elements of **Figures 6a - 6c (684, 688)**. The cable securing member **688** is pivotally attached to the termination module **730** at a pivot point **790** to allow movement between the first position A and the second position B. The cable securing member **788** is configured, in some embodiments of the present invention, to pivot

about a neutral axis having an arc length for a cable secured therein that is substantially the same in the first position A and the second position B to limit load on the cable secured therein during movement of the cable securing member **788** between the first position A and the second position B. A movement track **792** is provided including a securing member or bolt **794** for locking the cable securing member **782** in a desired position.

Figure 9 is a perspective view of an optical fiber splitter/splice tray **940** having a plurality of connectorized pigtails **950** according to some embodiments of the present invention. As shown in **Figure 9**, a mounting bracket **944** is mounted at one end of the optical fiber splitter/splice tray **940** and the pigtails **950** extend from an opposite end thereof. Connector plugs **951** are provided at the ends of the connectorized pigtails **950**. **Figure 10** is a perspective view illustrating an alternative optical splitter module arrangement using a splitter box **1040** having connectorized pigtails **1050** extending therefrom, rather than an optical fiber tray. The splitter box **1040**, like the splitter tray **940**, may be held in place in an interconnect cabinet by, for example, tabs and/or a bracket..

Methods for outside plant management of subscriber optical fiber connectivity according to some embodiments of the present invention will now be described with reference to the flowchart illustration of **Figure 11**. As shown in **Figure 11**, operations begin at **Block 1100** by providing a termination panel in an interconnect cabinet for optical fibers including a plurality of optical fiber connection points (connection members) and a splitter in the cabinet having a plurality of optic fiber connectorized pigtails extending therefrom. Such a termination panel, splitter and cabinet arrangement has been described previously with reference to **Figures 1-10**. The connectorized pigtails may have a cable length sufficient to allow connection to the plurality of connection points. The connectorized pigtails are optically spliced to an optical fiber feeder cable coupled to a central office (**Block 1105**). The plurality of optical fiber connection points (or connection members) are optically spliced to receptive subscriber locations (**Block 1110**). In some embodiments of methods according the present invention, ones of the connectorized pigtails are routed around selected ones of a plurality of fiber management spools based on a location of the connection points to which they are to be coupled (**Block 1115**). Ones of the connectorized pigtails are selectively coupled to ones of the connection points to provide service to the designated ones of the subscriber locations (**Block 1120**).

Similarly, ones of the connectorized pigtails may be selectively decoupled from one of the connection points to terminate service for a designated one of the subscriber locations.

The block diagram of **Figure 1** and the flowchart of **Figure 11** illustrate the architecture, functionality, and operation of possible implementations of methods for outside plant management of subscriber optical fiber connectivity according to some embodiments of the present invention. It should be noted that, in some alternative implementations, the acts noted in the blocks may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may be executed in the reverse order, depending upon the functionality involved.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited to the specific embodiments disclosed, and that modifications to the disclosed embodiments, as well as other embodiments, are intended to be included within the scope of the appended claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.